

Map Unit Properties Table

Age	Map Unit (symbol)	Unit Description	Topographic Expression	Erosion Resistance	Paleontological Resources	Cultural Resources	Hazards	Suitability for Development	Other
QUATERNARY	Alluvium (Qa)	Unconsolidated clay to gravel in streambeds, floodplains, and sheetwash.	Low relief	Low	May contain fossils eroded from other formations	Charcoal in channels incised into Kp; Middle Archaic component in alluvial fans	Flash floods	Low	None
	Flood- plain alluvium (Qfa)	Light- brown to gray clay, silt, & fine sand; discontinuous sandy & clayey gravel beds in lower part. Composed of sediments deposited during present erosional cycle of streams. Generally thicker along White & Cheyenne Rivers (avg thickness 7.6- 11 m, 25- 35 ft) than along tributaries. Grades laterally into terrace alluvium. Generally water bearing. Yields are adequate for domestic & stock needs, but differ because deposits are not uniform. Along some small tributaries deposits are thin: wells commonly go dry in late summer or early fall. Water levels, especially along rivers, respond rapidly to changes in streamflow. Includes colluvium mapped by the South Dakota Geological Survey (SDGS) on map HA- 357 (Ellis & Adolphson 1971). 0- 12 m (0- 40 ft) thick.	Flatlands adjacent to stream channels	Low	None documented in this report	None documented	None documented in this report	Floodplain	Groundwater quality good where alluvium is underlain by Tertiary deposits & generally poor where underlain by Cretaceous rocks.
	Terrace alluvium (Qta)	Light- brown clay, silt, & fine sand; thin discontinuous beds of med to coarse gravel at or near the top. Clayey & sandy gravel common in basal few ft, especially along the White River. As many as 5 terraces present at some locations. Water bearing where deposits extend below the water table of adjacent Qfa, or where water table is perched. Yields & water quality similar to those of Qfa. Not differentiated from flood- plain alluvium in S. Jackson & N. Bennet Counties, S of Badlands National Park, on HA- 357. 0- 18 m (0- 60 ft) thick.	Flat terraces adjacent to, but higher than, present floodplains	Low	None documented in this report	None documented	None documented in this report	Moderate	Groundwater where deposits extend below the water table of Qfa
	Landslide deposits (Ql)	Slumped masses consisting predominantly of shale (Kp), clays (Tb), & silt & ash (Ts). Common in areas of high local relief, particularly in Kp, upper part of Brule Fm, Rockyford Ash of Ts, & more frequent on east- facing slopes of map I- 934 (Raymond and King 1976).	Slumps	Low	None documented in this report	Late Archaic sites in prominent slump block deposits just below top of Wall	May destroy paleo and cultural resources	Unstable deposits	None
	Eolian sand (Qe)	Sand, predominantly as stabilized sand dunes & yardangs. Includes minor lenticular beds of older alluvial gravel on map I- 934.	Dunes & yardangs	Low	None documented in this report	Bison bone from Sheep Mtn Table; Paleo- Indian to Late Prehistoric material?	None documented in this report	Unstable	None
	Windblown sand deposits (Qwd)	Tan unconsolidated very fine to medium quartz sand. Water table generally is near the base of sand. Some deep depressions contain ponds because the water table intersects the land surface. Springs are common along the margins of the deposits. Yields commonly more than adequate for domestic & stock needs. Mapped only where areally extensive or water bearing on HA- 357. 0- 61 m (0- 200 ft) thick.	Dune topo.; small hills to 37 m (120 ft) high, closed depressions; partly stabilized by veg.	Low	None documented in this report	None documented	None documented in this report	Unstable deposits	Groundwater quality good (TDS generally less than 350 Mg/l).
	Older alluvium (Qoa)	Generally pediment deposits derived mainly from Tc & Tb & smaller amounts of high- level river gravels. The gravels consist of igneous, metamorphic, & sedimentary rocks characteristic of the Black Hills on I- 934.	Sod tables	Low where sod has been stripped off	None documented in this report	Bison bones, scorched rock from fire rings, worked stones, pottery on eroded toes of dissected sod tables	None documented in this report	Could impact sod tables	None
	Old terrace deposits (Qot)	Brown to light- brown silt, clay, sand, & gravel; layers often partly cemented by calcium carbonate; gravel & sand beds commonly interbedded with laminated silty clay. Form terraces generally parallel to the present White & Cheyenne Rivers & slope gently towards the rivers. Generally water bearing in basal few ft. Springs & seeps common along the riverside margins. Yields generally adequate for domestic & stock needs. Mapped where areally extensive or water bearing on HA- 357. 0- 24 m (0- 80 ft) thick.	Nearly flat isolated terraces; 24- 61+ m (80- 200+ ft) above present stream. Gentle slopes to rivers.	Low	None documented in this report	Middle Plains Archaic site; possible sites as old as 2800 to 10,500 years BP in Sage Creek Basin terrace fill	None documented in this report	Moderate	Groundwater quality good (TDS generally less than 500 Mg/l).
TERTIARY	Ogallala Formation (To)	<u>Upper unit:</u> Light- tan to light- gray calcareous, massive sandstone; thin discontinuous beds of limestone common near base. Beds of volcanic ash up to 3.4 m (11 ft) thick locally occur near the top. Mapped as the Ash Hollow Fm of the Ogallala Group by the Nebraska Geological Survey (NGS) & SDGS. Relatively impermeable; water bearing only locally because of high topographic position. 0- 46 m (0- 150 ft) thick. <u>Lower unit:</u> Light- gray to light- olive- green fine to medium, unconsolidated or poorly consolidated sand; lower part locally cemented with calcium carbonate. Small blowouts common in sandy areas. Mapped as the Valentine Fm of the Ogallala Group by the NGS & SDGS. Generally water bearing where areally extensive. Springs & seeps common at contact with underlying Arikaree Fm. Yields of most wells adequate for domestic & stock needs. 0- 6 m (0- 20 ft) thick. Shown only where mapped by SDGS or described in other published reports. Probably present over large areas in E Shannon, NW Bennet, & SW Jackson Counties (S of Badlands National Park) on HA- 357. Not exposed in Badlands National Park.	Upper unit: Thin cap rock on isolated buttes & ridges S of Badlands National Park; erodes to low but prominent bluffs. Lower unit: Forms gentle slopes between bluffs of underlying Arikaree Fm.	Upper unit: Forms cap rocks. Lower unit: Less resistant to erosion than upper unit.	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Lower unit: Groundwater quality good (TDS generally less than 250 Mg/l).

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TERTIARY	Arikaree Formation (Ta)	<p>Divided into units A, B, C, D, & E on HA- 357; Not exposed in Badlands National Park.</p> <p><u>Unit E:</u> Light- tan to brown; interbedded calcareous sand, silt, & clay; contains gray to pinkish- gray tabular concretions & small light- brown & greenish clay balls. Small blowouts & thin, isolated deposits of windblown sand are common. Mapped by SDGS as the Rosebud Fm. 0- 72 m (0- 235 ft) thick.</p> <p><u>Unit D:</u> Gray, massive, poorly consolidated, fine to very fine sands commonly contains layers of light- gray sandy marl, large concretions & small spherical concretions. Unit difficult to differentiate from underlying units. Mapped by SDGS as the Harrison Fm. 0- 38 m (0- 125 ft) thick. <u>Unit C:</u> Buff siltstone & very fine- grained sandstone. Difficult to distinguish from overlying & underlying units. Mapped as the Monroe Creek Fm by SDGS. 0- 27 m (0- 90 ft) thick.</p> <p><u>Unit B:</u> Pinkish- tan poorly consolidated silt & very fine- grained sand; gray, 5- 10 cm (2- 4 inches) calcareous concretions are common. Lenses of limestone & channel sand & gravel occur locally throughout the unit in the central & western parts of the Pine Ridge Reservation. Mapped as Ts by SDGS. 0- 114 m (0- 375 ft) thick.</p> <p><u>Unit A:</u> White, tan buff, & reddish- brown silty volcanic ash; interbedded with thin layers of silt. Caps buttes & tables in NW part of Pine Ridge Reservation. Also called the Rockyford Ash of Ts. 0- 14 m (0- 45 ft) thick.</p>	<p><u>Unit E:</u> Rolling hills <u>Unit D:</u> Rolling hills except along valleys where it forms steep slopes interrupted by small ledges <u>Unit C:</u> Forms cliffs along major tributaries; rolling, hummocky topo in upland areas. <u>Unit B:</u> Gently rolling grass-covered hills. <u>Unit A:</u> Forms prominent light-colored cliff between the Arikaree & White Rivers; caps buttes & tables in NW part of Pine Ridge Reservation</p>	<p><u>Units E, D, & B:</u> Erode to gently undulating, rolling hills. <u>Unit C:</u> More resistant to erosion than other units in Ta; forms cliffs. <u>Unit A:</u> More resistant than units E, D, & B; caps buttes & tables.</p>	<p>Not exposed in Badlands National Park</p>	<p>Not exposed in Badlands National Park</p>	<p>Not exposed in Badlands National Park</p>	<p>Not exposed in Badlands National Park</p>	<p>Most common source of groundwater on Pine Ridge Reservation. Yields vary, probably because of well location & method of completion, but are usually adequate for domestic & stock needs.</p>
	Sharps Formation (Ts)	<p>Massive poorly consolidated pinkish- tan silt containing calcareous concretions, local lenses of freshwater limestone, clastic dikes, & chalcedony veinlets. Basal unit, the Rockyford Ash, is a conspicuous white locally silty zeolitic volcanic ash up to 15 m (50 ft) thick. In many places, generally between Cedar Pass & The Pinnacles, the basal unit is a channel fill consisting of pebble conglomerate made up largely of fragments of calcareous nodules derived from ash layers & quartz sand in the upper part of Tb. Lithology is similar to that of the underlying Tb, but the color of Ts above the Rockyford Ash has a more brownish tone than that of Tb. About 100 m (328 ft) thick on map I- 934.</p>	<p>Cap highest levels of the badlands; form flat barren highland studded with sharp spires & near vertical walls formed by clastic dikes.</p>	Low	<p>Leptauchenia, Proscalops, Paleolagus, Palaeocastor, heliscomys, Nimravus</p>	<p>None documented</p>	<p>Fossil theft; mass wasting (slumping & rock fall)</p>	<p>Low</p>	<p>Part of Arikaree Gp. whose type section is in the Pinnacles area of the North Unit</p>
	Brule Formation (Tb) (White River Group [Twr])	<p>Interbedded pinkish- & greenish- gray clay, silt, sand, & volcanic ash containing channel sandstones, clastic dikes, & chalcedony veinlets. Contains a conspicuous oreodon & turtle fauna. Due to its high content of fine volcanic ash & calcareous cement, characteristically weathers to very steep slopes & knife- edge ridges. This characteristic alone provides reasonably clear delineation of the Brule- Chadron contact in the badlands. Too impermeable to serve as a groundwater source. Up to 150 m (490 ft) thick.</p> <p><u>Poleslide Mbr.:</u> Reworked eolian volcanics (siltstones) & occasional fluvial channel & overbank deposits; well developed paleosols; rare lacustrine carbonate; 50 m (160 ft) thick in the Cedar Pass Area.</p> <p><u>Scenic Mbr.:</u> Tuffaceous mudstones & fine- grained sandstones, with minor amounts of claystone, siltstone, & limestone.</p>	<p>Steep fluted cliffs & bluffs; Compose most of the Wall & many of the striking color-banded buttes.</p>	Low	<p>Conspicuous oreodont (Merycoidodon, Leptauchenia) & turtle fauna; horned sheep-sized herbivore (Proteroceras); aquatic rhinoceros (Metamynodon); camel, Poebrotherium wilsoni; coprolites, pollen, fossilized wood</p> <p>Pig Dig fossils: Mesohippus, Subhyracodon, Archaeothrium, Leptomyx</p>	<p>None documented</p>	<p>Fossil theft; mass wasting (slumping & rock fall); Route 240 Loop Road is built on several active landslides in Brule Fm.</p>	<p>Low due to erosion potential</p>	<p>World- class Oligocene fauna; Part of White River Gp. whose type section is in the Pinnacles area of the North Unit</p>
	Chadron Formation (Tc) (White River Group [Twr])	<p>Pale- gray- green bentonitic clay alternating with layers of greenish- gray siltstone; basal conglomerate & channel sandstone present in some areas. Contains a conspicuous titanotherian fauna. Divisible into an eastern & a western facies. Western facies, SW of Scenic, attains a maximum thickness of about 55 m (180 ft). Includes a thick basal conglomerate & channel sandstone sequence, which has filled stream valleys that were cut into the surface of the underlying Kp in pre- Oligocene time. Eastern facies, near Interior, the conglomeratic channel- fills of the basal Tc are missing, the formation is less than 7 m (23 ft) thick, & in some places it consists only of greenish- gray clay. Generally too impermeable to serve as a groundwater source, but local basal sandstones yield small amounts of water. 0- 34 m (0- no ft) thick.</p> <p><u>Peanut Peak Mbr.</u> (youngest): Exposed in North Unit</p> <p><u>Crazy Johnson Mbr.</u> (middle): Exposed in South Unit</p> <p><u>Ahearn Mbr.</u> (oldest): Exposed in South Unit</p> <p>Interior paleosol: Base of Tc; red weathering profile;</p>	<p>Erodes into low, rounded, barren "haystack" knolls</p>	<p>Low; sandstone & conglomerate more resistant than clay</p>	<p>Conspicuous titanotherian fauna (Brontotherium).</p> <p>Fossil variety in Tc & Scenic Mbr. of Tb: aquatic turtles (Graptemys); semi- aquatic rhinoceros (Trigonias); cursorial rhinoceros (Hyracodon, Caenopus), titanotheres (Menodus), horses (Mesohippus), creodont carnivores (Hyaenodon), oreodonts (Merycoidodon), pig- like entelodont (Archaeotherium)</p> <p>Other fossils: alligator; frog; lizard; birds; opossum; small insectivore; rodent; saber-tooth cat; tapirid; peccary; camel; squirrel-like, deer- like, rabbit- like, and fox- like animals.</p> <p>Interior paleosol: fossil termite nests; other burrows</p>	<p>None documented</p>	<p>High bentonite content; sheet wash; mass wasting (slumping); fossil theft</p>	<p>Low due to bentonite problems</p>	<p>World- class Titanotherian fauna; Part of White River Gp. whose type section is in the Pinnacles area of the North Unit; Type section for the Chadron Fm is in the town of Chadron in NW Nebraska.</p> <p>Groundwater quality fair (TDS between 600 & 1,000 Mg/l).</p>

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	Chamberlain Pass Formation, White River Grp (mapped as Interior Beds, Kpi)	Conglomerate, sandstone, shale; flood plain deposits (lacking gravel) in Sage Creek Wilderness Area in North Unit; indistinguishable from the Interior paleosol in North Unit.	Conglomeratic beds may cap buttes	Variable	Eocene fossil tooth found in gravel deposits	None documented	Mass wasting (slumping & rock fall)	Variable	Part of White River Gp. Type section about 10 km (6 mi) SW of Kadoka, SD
UPPER CRETACEOUS	Yellow Mounds Paleosol (not mapped)	Yellow, sandy A- horizon; red, silty-claystone B- horizon; large clay-filled root channels extending deep into C- horizon; dense calcium carbonate horizon at depth. Parent material is weathered Kp or Fox Hills Fm, where present.	Developed on hilly, rolling terrain	Low	Root casts and other soil formation features	None documented	None documented in this report	Low due to erosion potential	Type section
	Fox Hills Formation (mapped as Interior Beds, Kpi)	<u>Unnamed marine facies</u> : Sandstone & shale; interbedded; flat-lying beds; sand sheets are 1-15 cm (0.4-6 in) thick; body fossils scarce; abundant marine trace fossils (<i>Skolithos/Cruziana</i> ichnofacies); best exposures in Grassy Tables Overlook area; 0-16 m (0-52 ft) thick. <u>Enning Mbr</u> : Green & red fossiliferous marl; occurs in scattered outcrops along northern park boundary & north of park; 0-8 m (0-26 ft) thick. <u>Timber Lake Mbr</u> : buff & brown sandstone & shale; large, reddish-brown, fine-sandy textured concretions; Disturbed Zone (DZ) -Interval of soft-sediment deformation throughout park area; E- to- W roll structures; soft-sediment features (roll structures, clastic dikes, slump glide-plane surfaces, dewatering structures) do not penetrate overlying & underlying strata; up to 16 m (52 ft) thick. <u>Trail City Mbr</u> : gray sandy mudstone & shale; large, brown weathering, ironstone concretions in hilltops around Sage Creek Campground; Timber Lake and Trail City Members combined thickness of 6-26 m (20-85 ft).	Within slopes & cliffs along streams & tributaries (unnamed facies & DZ); ledge-forming sandstone beds cap hilltops; Timber Lake concretion beds form bench-like surfaces	Variable: Sandstone more resistant than shale	<u>Unnamed marine facies</u> : Trace fossils include: <i>Diplacraterion</i> , <i>Ophiomorpha</i> , <i>Thalassinoides</i> , <i>Cruziana</i> <u>Enning Mbr</u> : Common belemnite, <i>Belemnitella bulbosa</i> ; also fish remains, plants, tiny clams, oyster frags <u>Timber Lake & Enning Mbrs</u> : Ammonite, <i>Jeletzkeytes nebrascensis</i> ; DZ: Trace fossils; charcoal & fragmented plant material <u>Trail City Mbr</u> : Fossilcasts, arthropod parts, fossil wood, rare sharks teeth	None documented	None documented in this report	Variable	Southernmost exposures of Fox Hills Fm; exposed along northern margin of the park.
	Pierre Shale (Kp)	Black to dark-gray marine shale & mudstone. Fissile, carbonaceous, poorly resistant to weathering. Layers contain bentonitic beds, large concretions & marine fossils. Channels in the old erosion surface have been mapped SW of Scenic where they form a drainage system about 6 km (4 mi) wide. Upper part of Kp, where it is in contact with the overlying Tc, is deeply weathered, up to 17 m (55 ft) thick, & the dark shale has been altered to red, yellow, & orange claystone. Basal 23-30 m (75-100 ft) consists of very dark-gray fissile shale with numerous beds of bentonite. Not a groundwater source. About 610 m (2,000 ft) thick. Subdivided into 5 members (from youngest to oldest) (Stoffer 2003): <u>Elk Butte Mbr</u> : Noncalcareous, very dark-gray, fissile shale with large, light-gray concretions that lack fossils; exposed along the S side of Sage Creek Anticline in Grassy Table Overlook area & at creek level in the core of the Sage Creek Anticline in Dillon Pass/Conata Creek Basin area; 0-50 m (0-164 ft) thick. <u>Mobridge Mbr</u> : Calcareous shale with intermittent layers of concretionary limestone; best exposed along upper hillsides along the South Fork & Middle Fork valleys in the Sage Creek Wilderness Area; about 5 m (16 ft) thick. <u>Virgin Creek Mbr</u> : Gray to greenish-brown or olive shale with numerous, thin, yellowish bentonite beds; exposed throughout the middle hillside slopes of Sage Creek Valley (North Unit) & most of South Unit; 10-20 m (32-66 ft) thick. <u>Verendrye Mbr</u> : Gray fissile shale with abundant limestone concretions; exposed along Sage Creek (North Unit) & Cedar Creek (South Unit); concretions are septarian, mostly barren of fossils but with some fossil debris; max 15 m (50 ft) thick <u>DeGrey Mbr</u> : Dark, reddish-gray, fissile shale with thin yellow bentonite (jarosite) beds; exposed along Cheyenne River Valley & Indian Creek W of Scenic; scarce fossils; incomplete section.	Generally erodes to rolling topography with deeply incised streams	Low; Mobridge Mbr is more resistant to erosion than the underlying & overlying strata	Elk Butte Mbr: unnamed species of baculites is common; <i>Hoploscaphites melloi</i> ; <i>Hoploscaphites birkelundi</i> Mobridge Mbr: <i>Baculites clinolobatus</i> Virgin Creek Mbr: <i>Baculites grandis</i> Verendrye Mbr: <i>Baculites compressus</i> ; <i>Baculites cuneatus</i> ; <i>Baculites reesidei</i> ; <i>Inoceramus sagensis</i> (large clam) DeGrey Mbr: <i>Didymoceras cheyennense</i> ; <i>Baculites corregatus</i> ; <i>Inoceramus sagensis</i>	None documented	Bentonite; Sage Creek Rim Road built on major landslide in Pierre Shale	Low due to bentonite problems	Deposited in the last of the great inland seas to inundate the North American continent.
	Niobrara Formation (Kn)	Upper third consists of yellowish-gray to pale-yellow shaly limestone. Where in contact with Tc, the upper 6-8 m (20-25 ft) of Kn is deeply weathered to a red, yellow, & orange noncalcareous claystone. Lower two-thirds consist of light-grayish-yellow to brownish-yellow very calcareous shale, with scattered thin interbeds of dark-gray noncalcareous shale. Normally not a groundwater source. Approximately 0-99 m (0-325 ft) thick. Not exposed in Badlands National Park.	Upper third: Steep bluffs with thin limestone ledges. Lower two thirds: Rolling grasslands	Limestone ledges more resistant than shale	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Not exposed in Badlands National Park	
	Carlile Shale (Kc)	Dark-gray to brownish-gray marine shale & mudstone. Large septarian concretions common in the upper third. Middle part is sandy & contains thin limestone ledges locally. Not a groundwater source. Approximately 30-99 m (100-325 ft) thick. Not exposed in Badlands National Park.	Gently rolling grass-covered hills	Low	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Not exposed in Badlands National Park	Not exposed in Badlands National Park	

Map units and descriptions for this table and accompanying GIS map are from: Ellis, M.J. and D.G. Adolphson. 1971. Hydrogeology of the Pine Ridge Indian Reservation, South Dakota. U.S. Geological Survey Hydrologic Investigations Atlas, HA-0357, scale 1:250,000.

* Not mapped on map HA-0357 but described by Stoffer (2003) in Badlands National Park